

CHAPTER 8. DRILLING AND BLASTING IN ROCK EXCAVATION BY CONTRACT

8-1. General. The CE designs and supervises excavation projects necessitating drilling and blasting by contractor forces. Many of these excavations can tolerate only minimal blast effects on the rock mass immediately adjacent to the lines and grades. Such excavations are designed to be economical and yet to meet certain design criteria of the final installation. Elsewhere, the Government has an interest in fragmentation obtained in blasting rock, intended to be utilized for rock-fill embankments and slope protection. Successful economical completion can be accomplished, but it usually demands considerable effort in planning, design, and inspection.

a. Customary Contract Approach. It is customary in construction contracts that unit bid prices for the items "rock excavation," or in some cases "excavation unclassified," include all costs of drilling and blasting. If the rock outlining the excavation is to be protected, it is common practice to describe the results required of the excavation operation by statements in the specification to the effect that: (1) the explosives used shall be of such quality and power and shall be used in such locations as will neither open joints nor crack or damage the rock outside the prescribed limit of excavation, (2) as the excavation reaches final lines and grades, the depth of holes for blasting and the amount of explosives used per hole shall be progressively reduced, and (3) excavation that exceeds the prescribed tolerance of lines and grades will be backfilled with prescribed materials. Other restrictions or limitations may also be included. It is the responsibility of the contractor to select the methods and operate in a manner that will produce the required results. It is expected that a prudent contractor will include in his bid a contingency item based on his judgment of the difficulty of the required work. Some specifications go further and prescribe routine procedures such as presplitting. The degree of responsibility of the contractor for the success of these procedures depends to some extent on the latitude and options given the contractor in the manner of employing the procedures. This general industry-wide approach to rock excavation in contracts meets with varying degrees of success. Where the rock excavation required is essentially the removal of large quantities of rock exemplified by highway cuts, the unit price of rock excavation has remained relatively stable over the last decade. However, when rock excavation requiring more exacting results is considered, disputes and controversies are common and may lead to claims for additional cost.

b. Variation of Customary Approach. It is considered to be to the best interest of the Government to reduce the element of risk for the

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contractor as far as practicable in bidding on Federal contracts. This is done in the effort to secure the most competitive bidding by reducing the contractor's need to add a contingency item for possible costs not specifically anticipated. There is evidence from CE projects that this approach is applicable to specifications regarding blasting. When there is sufficient knowledge from previous work and from geologic data to determine that certain blasting techniques, procedures, or limitations will probably be necessary to complete the work, this information should be included in the plans or specifications in some manner. Where it is essential that the final lines be obtained with close tolerances and the rock be undisturbed, the plans and specifications should outline in detail such requirements so the bidders can estimate accordingly. There is somewhat of a precedent to this approach in that the CE practice for Civil Works construction requires compaction of embankments on the basis of specified compaction procedures and moisture control, rather than on the basis of a required end product.

8-2. Considerations in Preparation of Plans and Specifications.

a. Stated Principles of Plans and Specifications. A general principle applicable to all CE contract plans and specifications is that they will be carefully prepared to eliminate all conditions or practices that might operate to delay the work or that might result in controversy (see ER 1110-2-1200, para 7a). Further, specifications should be so clear and complete that any competent manufacturer or construction firm should experience no undue difficulty in preparing bids or estimates. Questions that may arise during performance of the contract should be resolvable by reference to the contract, of which the specifications form a part (see ER 1110-2-1200, para 7d).

b. Pertinent General and Special Provisions. As rock excavation is not covered by guide specifications, recently approved and successful project specifications or sections thereof may be used as guides to the extent they are applicable. All technical provisions are subordinate, first, to the General Provisions and, second, to the Special Provisions of the general contract. The following is a list of those provisions that are deemed most pertinent to rock excavation; they should be reviewed and kept in mind during the preparation of plans and specifications.

General Provisions

- Clause 2—Specifications and Drawings
- Clause 3—Changes
- Clause 4—Changed Conditions
- Clause 6—Disputes
- Clause 9.b.—Materials and Workmanship

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Clause 12—Permits and Responsibilities
Clause 14—Other Contracts
Clause 23—Contractor Inspection System
Clause 32—Site Investigations
Clause 34—Operations and Storage
Clause 39—Additional Definitions
Clause 40—Accident Prevention
Clause 41—Government Inspection
Clause 50—Value Engineering
Clause 62—Variations in Estimated Quantities

Special Provisions

Physical Data
Variation in Estimated Quantities—Subdivided Items
Layout of Work
Quantity Surveys
Damage to Work
Approved Material Sources
Payment
Authorized Representative of Contracting Officer
Contractor Quality Control

c. Geologic Data. Data developed from geologic investigations affect the design, preparation of plans and specifications, and the pricing placed on the required rock excavation by the contractors in bidding the work. The responsibility for presenting an accurate description of materials to be excavated rests with the Government. EM 1110-1-1801 and EM 1110-1-1806 should be consulted in this regard.

d. Review Plans for Practicality of Excavation Outlines. During preparation of plans and specifications, the design should be reviewed for the practicality and the degree of difficulty in obtaining the various excavation outlines. These should be considered as to the possibility of attainment compared with their probable cost. For example, exterior vertical corners at right angles may be eliminated and replaced by battered corners.

e. Construction Inspection To Be Expected. Reference should be made to paragraphs 2-27 and 103-03(d) in EP 415-1-261.

f. Blast Records. The specifications should require the contractor to furnish the Contracting Officer complete information on every blast. Where a proposed general blasting plan is required prior to the start of blasting, the individual blast reports may be submitted after

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the blast. On other projects, proposed blast data have been required before drilling commences on each blast with a final report required after the shot is fired. Information should include location of blast by station and range; elevation of top of blast; depth, spacing, burden, number, and diameter of holes; type and quantities of explosives; quantities of detonating cord used; quantities and delay periods of electrical caps; maximum quantity of explosive detonated in a single delay period; a sketch of drill-hole pattern; number of cubic yards blasted; and powder factor. Fig. 8-1 shows one type of form provided to contractors by the Associated General Contractors of America, Inc. Fig. 8-2 illustrates a sample of a blast report form.

g. Sequence of Operations. Where there are technical reasons for excavation to proceed in a particular sequence, this requirement should be clearly defined in either the plans or specifications.

h. Specifying Methods—Obtaining Sound Walls. Where experience and geologic data indicate that a method such as presplitting is necessary to obtain the desired results, specify the method, or methods if an option can be given. Each method should be described in sufficient detail so that no item is omitted that might prove to be essential for its success. Allow enough latitude that the method can be adjusted to the field conditions and to contractor's proposals. Any contractor's proposal shall be described in detail and demonstrated to give equal and satisfactory results. When specifying presplitting, it is well to keep in mind that in some rocks, right-angle, outside corners of excavations are not too successfully obtained. Provisions for line drilling outside corners should be considered. Locally the burden in front of the pre-split wall will need to be blasted in small shots to a free face.

i. Obtaining Final Grade. The use of angle holes and limitation on the depth of a final lift should be considered if they will be helpful in obtaining the final grade without damaging the underlying rock.

j. Specifying and Prohibiting Certain Practices. It is sometimes beneficial to provide in the specification for the use of such measures as deck-loaded and small-diameter holes that may be deemed necessary later. Undesirable practices, such as subdrilling below specified tolerances in structural excavations, should also be prohibited.

k. Requiring Gradation Ranges in Blasted Rock. When blasting results are desired to produce certain fragmentation, test blasting should be performed by the contractor to demonstrate that he will produce the desired product. In certain rock types there is often

EXPLOSIVE SIZE **1 1/2" x 8"**
EXPLOSIVE TYPE **40% - Gel Dupont**
DELAY TYPE **M/5-1, 2, 3, 4**
TYPE OF ROCK **Mica Schist**
BLASTER **J. Jones**

Identify Job location by station or dimension to known structure or object. Show North Point.

BLAST STATION **0 + 50 on B Street**
DATE **2-1-58** TIME **10:05 A.M.**
DISTANCE TO NEAREST BUILDING **60'**
DISTANCE OF THROW **None**
DIRECTION OF WIND **N.W. temp 40°**
WERE MATS USED? **Yes**

HOLE NO.	HOLE DEPTH	DELT NO.	NO OF STICKS	NO OF POUNDS
1	18'	1	20	10
2	18'	1	20	10
3	18'	2	25	12.5
4	18'	2	25	12.5
5	18'	3	20	10
6	18'	3	20	10
7	18'	+	18	9
8	18'	+	18	9
9				
10				
11				
12				
13				
14				
15				
TOTAL				89.0

(Courtesy of The Associated General Contractors of America, Washington, D. C.)

Fig. 8-1. Example of one form of blasting log kept by contractor

EM 1110-2-3800
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SHOT RECORD

*PROJECT: _____		SHOT NO _____
*CONTRACTOR: _____		*DATE: _____
*PURPOSE OF BLAST _____		*TIME: _____
DRILLING DATA		
*LOCATION: _____	*STA: _____ TO _____	
	*RN: _____ TO _____	
	SURFACE ELEV: _____	
	BOTTOM ELEV: _____	
	GEOL FMTN'S: _____	
	VOL: L _____ X W _____ X H _____ = _____ CY	
	*DRILL TYPE: _____ DRILL ANGLE: _____	
	*HOLE DIA: _____ SLOPE (FREE FACE): _____	
*NO OF HOLES: _____	*DEPTH: _____	*PATTERN: _____
EXPLOSIVE DATA		
*TOTAL AMT: ① _____ LBS	*TRADE NAME: _____	*STN: _____ *SIZE: _____
② _____ LBS	_____	_____
③ _____ LBS	_____	_____
④ _____ LBS	_____	_____
POWDER FACTOR: ① _____ LB/CY	② _____ LB/CY	③ _____ LB/CY ④ _____ LB/CY
		TOTAL: _____ LB/CY
DETONATORS:		
*TYPE _____	DETONATING FUSE _____	
*PERIODS: 1 1 2 3 4 5 6 7 8 9 10 11 12 13 14		
*LOADING DIAGRAM:		
<div style="display: flex; justify-content: space-around; align-items: center;"><div style="border: 1px solid black; width: 20px; height: 80px;"></div><div style="border: 1px solid black; width: 20px; height: 80px;"></div><div style="transform: rotate(-30deg); font-size: 48px; font-weight: bold; opacity: 0.5;">SAMPLE</div></div>		
RESULTS		
EXCAVATION METHOD: _____		
QUANTITY OF ROCK PRODUCED: _____		
*FRAGMENTATION: _____		
PRE SPLIT RESULTS: _____		
COMMENTS _____		
*FURNISHED BY CONTRACTOR _____		
		SIGNED _____
		INSPECTOR OR CONTRACTOR

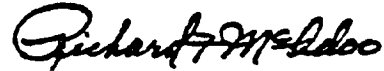
Fig. 8-2. Sample record of blasting

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considerable percentage of rock "wasted" in order to obtain required gradation. Allowance for this should be made when estimating quantities of rock necessary to produce the desired product.

1. Vibration and Damage Control. See EM 385-1-1.

FOR THE CHIEF OF ENGINEERS:



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2 Appendixes

APP A - References

B - Typical CE Blasting Specifications